Egyptian Developmental Screening Chart (EDSC)

El Shafie AM, Omar ZAL, Bashir MM, Mahmoud SF, Basma EM, Hussein AE, Mostafa AM, Bahbah WA. 2020. Development and validation of Egyptian developmental screening chart for children from birth up to 30 months. PeerJ 8:e10301 http://doi.org/10.7717/peerj.10301

Development and validation of Egyptian developmental screening chart for children from birth up to 30 months

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El Shafie et al. (2020), PeerJ, DOI10.7717/peerj.10301

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Egyptian Developmental Screening Chart (EDSC) questionnaires

Items (1-54)	Translation in English	بيانات التطور العقلى والحركى	
1. Arms & Legs thrust in play.	When the baby is lying on bed (without restrictive clothing). Does he/she make spontaneous movements of limbs playfully?	يحرك يداه وقدميه علي الجانبين (يشقل بيديه ورجليه)	**شهر**
2. Momentary regard.	Does the child look at you? (It is not a vacant look)	يركز بعينيه علي وجه الام للحظات او للضوء	
3. Lateral head movement (prone).	When the child is put on the tummy. Does he/she move the head to side to clear the nose? (Some parents will say that they have not put the child prone. The item may be tested by the assessor)	يحرك رأسه للجانبين وهو نائم علي بطنه	**شهران**
4. Responds to sound.	Does the child respond in any way to ordinary sound (voice, rattle, etc)?	يتخض او يسكت عند سماع الأصوات العاليه مثل (الكلام،الشخشيخه)	
5. Follows moving person.	If you move a little when the child is looking at you, does the child follow you with eyes?	يتابع بعينيه الأم عندما تتحرك أو عند تحريك لعبة أمامه	
6. Free inspection of surrounding	Does the child look around as if he/she is observing things? (a subjective opinion of the parents but can be relied upon)	بيحرك عينيه ليكتشف المكان حوله.محاولا ملاحظة شئ أمامه.	

7. Social smile/vocalize.	When you talk or make gestures to the child, does he/she respond with a smile of cooing?	يبتسم وبيناغي بصوت واضح عند الكلام معه أو إصدار أصوات له.	**3 أشهر**
8. Eye co-ordination.	Is the child able to look around in all directions (up-down, right-left)?	هل الطفل قادر علي النظر حوله في كل الإتجاهات (لأعلي- أسفل، يمينا- يسارا).	
9. Head erect & steady.	When the child is held at shoulder, does he/she raise the head up for some time or lifts momentarily and drops it down? – (Not lifting momentarily and dropping it down.)	يرفع رأسه لفتره عندما تحمله الام علي كتفها.	
10. Holds head steady.	When the child is held vertical by armpits does he/she keep the head steady without wobbling?	يرفع رأسه بثبات عاليا عند رفعه قائما من أسفل اللإبط (الرأس عموديه دون ترنح)	**4 أشهر**
11. Recognizes mother.	Do you feel that the child recognizes you? If the child is crying or restless, do the child's behaviour /expression change when the child sees you are is touched or lifted by you? (A very subjective item but mother's guess is usually right and often they are proud to confirm this!)	يبتسم عند رؤية أمه، يهدأ عندما تأتي.	
12. Elevates on arms.	When put on the tummy (prone), does the child lift the chest off the bed by pushing on the elbows – bearing weight on the arms? (If the parents say that they do not put the child prone, clarify the situation as in item no.3)	عندما ينام علي بطنه هل يكون قادر علي رفع صدره من على السرير بالإستناد علي مرفقه أو يرفع جسمه بالإستناد عي ذراعه.	
13. Play with rattle /hand play.	When a rattle is placed in the hand of the child, does he/she look / mouth / shake or play with it in any other way?	عندما توضع شخشيخه بيده هل الطفل ينظر إليها ،يضعها بفمه ،يهزها أو يلعب بها بأي طريقه أخري	

14. Reaches for dangling ring.	Does the child show interest in some thing around and try to reach it by extending the arm? (The child may not be able to actually reach and secure it)	هل الطفل يبدي إهتمام بالأشياء حوله ويحاول الوصول لها بمد ذراعه(لايشترط أن يستطيع الوصول لها)	**5 أشهر**
15. Sits with slight support.	Is the child able to sit for some time when the legs are spread and slight support given at back? (Many parents may not have tried this but the assessor can test this item)	يجلس مستند علي وسادة او ذراع الأم عندما تكون القدم مفرودة.(يمكن أن تختبر بواسطه الطبيب).	
16. Turns head to sounds.	If you shake a rattle or make some soft sound on one side, does the child try to look towards the side of the sound?)	يلتفت للأصوات المختلفه (الناس ، التلفاز أو صوت الشخشيخه)	
17. Turns from back to side.	When the child is lying on the back, does she/he turn to one or other side?	بيتقلب من علي ظهره الي جانبه	**6 أشهر**
18. Exploitive paper play.	Does the child play with paper given in hand (crumpling, mouthing etc.)?	هل الطفل يلعب بالورق عند إعطائه له مثل (وضعها بفمه أو يطويها بيده لتصدر أصوات)	
19. Discriminates strangers.	Does the child's attitude or mood change if strangers come?	يقلق من الغرباء (يبكي ،يبعد ،يحدق)	
20. Pulls to sit.	If you give your thumbs to the child lying on bed, does he/she pull self to sitting position without you pulling the child?	يهم ليجلس بمفرده من وضع الأستلقاء عندما يمد الأهل يده لهم ؛دون مساعده لشد الطفل.	**7 أشهر**
21. Bangs in play.	When the child has a toy in the hand, does he bang it on the floor in play to produce sound?	يضرب الاشياء ببعض أو بالأرض لأصدار أصوات مثل (المكعبات، الاطباق)	
22. Sits alone steadily.	When you make the child sit, does he/she keep sitting even when your support is removed?	يجلس مستقيما دون الحاجه لدعم لعده دقائق.	

23. Retails two things in two hands.	When the child is holding a toy in one hand and you give him another in the other hand, does he/she hold on to both (or drop one and hold only one)?	عند إعطاء الطفل لعبه في يده و هو ممسك لعبه بيده الأخرى. هل يظل ممسكا باللعبتين في نفس الوقت؟.	**8 أشهر**
24. Pulls to stand.	When the child is sitting and you give your hands to hold, is the child able to pull himself/herself standing by his own effort – without your pull?	عندما تمد الأم يديها للطفل و هو جالس هل يحاول شد نفسه ليقف دون مساعدة	
25. Playful response to mirror image.	When the child sees image in the mirror, does he/she show interest by approaching, patting or other playful activity?	يضحك،يصدر أصوات عند النظر للمرآه	
26. Sits with good co-ordination.	Is the child able to sit with full control – if there is a toy by the side, can the child turn his trunk and secure it without losing balance (pivot)?	يجلس دون مساعده وقادر علي الالتفات،او يهم ليزحف محاول الوصل للعبه بعيده دون فقد توازنه.	**9 أشهر**
27. Pulls string-secures toys.	If a stringed toy is somewhat away with the sting end within reach of the child, does the child pull the string to secure the toy? (Sometimes, parents answer this query affirmatively saying that the child can hold and pull a string. This is an item from the mental scale. The item aims to know whether the child has the concept of the connection and is aware that he can get the toy by pulling the string)	يشد مفرش لتقريب اللعبة منه (هل تشعر الأم أن الطفل يسحب المفرش بهدف الحصول علي اللعبة؟).	
28. Co-operates in play.	If you play simple games like peek-a-boo (Kukdi-kook, or zak-fu), or some rhythmic activity like clapping, does the child like it and co-operate in the activity? (e.g. pull the kerchief from the face and hand it over to you).	عندما تطلب منه لعبه يمد يده ليعطيها لك حتي لو لم يتركها.هل يتجاوب عنداللعب معه (إستغمايه او يفرح ويصدر أصوات مع التصفيق)	**10 أشهر**

29. Crawling (pre walking).	When the child is on the floor, does he/she move from one place to another wilfully (e.g. to get a toy)? The child may move in any manner – crawling, creeping, bear walk, hitching or as some disabled children do, roll or by pulling ahead with upper arm movements only. (Some infants lift the chest but not the pelvis and get pushed back – this is not considered pre-walking progression)	الطفل يحبي أو يتحرك من مكانه اما بالحبو على البطن مثل الكوماند أو الزحف علي يديه و ركبتيه أو الزحف علي اليدين و القدمين مع المؤخرة في الهواء مثل الدب	
30. Rings bell purposefully.	Does the child shake a rattle purposefully to produce the sound (the sound should not be accidentally produced)	هل الطفل يهز الشخشيخه عن قصد لتصدر أصوات.	
31. Fine prehensions.	Does the child pick up small objects like puffed rice or crystal sugar by the tip of forefinger and thumb?	يمسك الاشياء بسلاسه بواسطه أطراف اصابعه السبابه والوسطي (مثل حبة أرز)	**11 أشهر**
32. Raises to sit.	Is the child able to sit up from lying position all by self – without taking any external support?	يجلس دون مساعده	
33. Stands by furniture.	Is the child able to stand up by taking support of furniture or other objects? (Sometimes parents report that when they are standing near the child, the child pulls to stand by help of their clothes – that is OK)	يقف ممسكا بالاثاث	**12 أشهر**
34. Adjust two words.	Does the child know some objects by name? If you ask the child where an object is, an object around without pointing the direction, does he/she look towards it? (Child may need to be asked in his/her language – tik-tik for clock, gir-gir for fan, or pa-pa etc.)	يعرف بعض الأشياء بأسماءها عندما يسأل عن مكان شئ دون الأشاره اليه ،هل الطفل ينظر إليها ؟	

35. Says da-da.	Does the child speak repeated syllables like da-da, ma-ma? (These are not meaningful words)	يقول كلمه من مقطعين با –با ، ما – ما ،نا-نا	
36. Inhibits on command.	When the child is engaged in some activity, does he stop at least momentarily if you command him/her firmly (but not threateningly)?	عند أمر الطفل بالتوقف عن فعل شئ اثناء أنشغاله به ، هل يتوقف ولو للحظات؟ (عندما تأمر الام بحذم و ليس بالتهديد) مثال: كخ أبعدها او اوف شيل ايديك	**13 الى 15 شهر**
37. Midline skills.	Does the child clap or perform similar action (e.g. ‘radhe-radhe, ‘namaste’’)?	يصفق أو يمسك لعبه علي جانبه الايسر بيده اليمني، يلمس ذراعه الايسر بيديه اليمني، يضع رجل علي رجل وهو نائم علي ظهره.	
38. Walks with help.	Is the child able to a few steps when made to stand holding your two hands (but without getting physical support? (Sometimes, the parents report that the baby when made to stand with support of a stool or small furniture or walker pushes it and walks. This would not be considered as ‘pass’ because the child is leaning and getting physical support from the piece of furniture).	يمشي بضع خطوات وهو ممسك بيدين الأم (لا يعتد بالمشايه او الاثاث الصغير)	
39. Turns pages.	If the child gets a picture book in his hand would he turn the pages to see more pictures? (or just try to pull and tear the pages?)	يقلب الصفحات لمشاهدة صور أكثرأو يحاول قطع الورق فقط	

40. Imitates words.	Is the child able to repeat repetitive sound with some meaning (like meh-<eh, Bhu-Bhu, Da-Da When asked? The parent should make those sounds and ask the child to reproduce them. (The child may be babbling repetitive sounds but this is ability to produce willfully what one has heard)	يقصد الطفل ان يصدر أصوات ذات معني شبيه للكلمات التي يرددها الاهل امامه ليقلدها. مثال: ما-ما، با-با، تا-تا	
41. Stands alone.	When the child is put in standing position and the support withdrawn, does he/she stand independently at least for a short time?	يقف دون مساعده لفتره قصيره بعد مساعدته علي الوقوف وأزاله الدعم عنه.	**16 الى 18 شهر**
42. Spontaneous scribble.	If the child gets hold of a pencil or pen, does he/she try to make marks on a paper or any other surface (it may be floor, table top, and wall)?	يشخبط بالألوان	
43. Throws balls.	Is the child able to throw or fling a ball (not just roll or drop in)?	يرمي الكره بعيدا عندما يمسكها بيديه الاثنين.	
44. Aufstehen 1.	Is the child able to stand up from lying down position by his own efforts without any external help?	هل الطفل يستطيع الوقوف من وضع الأستلقاء إلي وضع الوقوف دون أي مساعده خارجيه	
45. Walks alone.	Does the child take a few steps independently? (Even if the child is not standing up by self, he/she may be able to take a few steps when made to stand and removing the support – as in item 41)	يمشي بضع خطوات بمفرده دون ان يمسك بشئ،حتي ولو كان لا يستطيع الوقوف بمفرده (عندما تساعده علي الوقوف وتتركه يستطيع ان يمشي).	
46. Gestures for wants.	Does the child tell what he wants by pointing to the things and/or by gestures (nodding pushing away etc,)	يهز رأسه بالرفض ،يشير لكوب الماء ليشرب ، يشير للعبه يريدها ويبكي لاحضارها	**19إلي 24 شهر**

47. Shows shoes, etc.	Is the child able to identify some objects belonging to him/her (like shoe, dress, and toy)?	يتعرف علي أشياءه مثل (حذائه، لعبته، ملابسه)	**19إلي 24 شهر**
48. Two words.	Is the child able to speak two words meaningfully? (This may be in his own language– 'bhoo' for water, 'mum-mum' for food. Earlier, 'ba-ba' may be babbling, now it may mean a particular person	ينطق كلمتين واضحتين ويعرف معناهم مثل (بوه ،مم)	
49. Walks up &down stairs with help.	Is the child able to walk up or/and down the steps by holding the railing or the caretaker's hand? (Climbing up the stair on fours and climbing down in sitting position is not to be considered "pass')	يمسك بيد والديه أو السور اثناء صعود وهبوط السلم(لا يعتد بالصعود زحفا او جالسا)	
50. Words for wants.	Does the child use words to tell what he wants – may be in 'baby' language?	يشير للشئ مع قول اسمه صحيح(كره) حتي بلغه الطفل	
51. Two words sentences.	Is the child able to speak a meaningful sentence of two words? (e.g. papa out)	يتحدث بجمل مكونه من كلمتين مثل (اريد اشرب،أريد اكل، بابا خارج)	**25 إلي30 شهر**
52. Names three objects.	Is the child able to name three common objects (ball, fan, mama, Papa etc.) (The child may speak in 'baby' language)	يسمي ثلاثة أشياء بأسمائها مثل صوره (كلب، قطه،حصان، بابا ،ماما)	
53. Stands on one foot.	Is the child able to stand on one foot for some time? (Standing on one foot while walking is not to be considered)	يقف علي قدم واحده (مثال: عند لبس البنطلون او الحذاء)	
54. Walks up & down stairs without help.	Is the child able to walk up or/and down the steps without holding the railing or the caretaker's hand?	يستطيع ان يصعد ويهبط دون ان يمسك بالسور	

Appendix of 54 items of EDSC questionnaire

1st Month	**1. Arms & Legs thrust in play.** 
	2. Momentary regard. 

2nd Month	**3. Lateral head movement (prone).** 
	4. Responds to sound. 
	5. Follows moving person. 
	6. Free inspection of surrounding 

3rd Months	**7. Social smile/vocalizes.** 
	8. Eye co-ordination. 
	9. Head erect &steady. (head control partial) 

4th Months	**10. Holds head steady.** 
	11. Recognizes mother. 
	12.Elevates on arms. 
	13. Play with rattle /hand play. 

5th Months	**14.Reaches for dangling ring.** 
	15.Sits with slight support. 
	16.**Turns head to sounds.** Child try to look towards the side of the sound

6th Months	**17.Turns from back to side.** 	
	18. Exploitive paper play. (crumpling, mouthing) 	
	19. Discriminates strangers. 	

7th Months	**20. Pulls to sit.** 
	21. Bangs in play. 
	22. Sits alone steadily. 

8th Months	**23. Retails two things in two hands.** 
	24. Pulls to stand. 
	25. Playful response to mirror image. 

9th Months	**26. Sits with good co-ordination.** 
	27. Pulls string-secures toys. **The item aims to know whether the child has the concept of the connection and is aware that he can get the toy by pulling the string**

10 Months	**28. Co-operates in play.** 
	29. Crawling (pre walking). 
	30. Rings bell purposefully. 

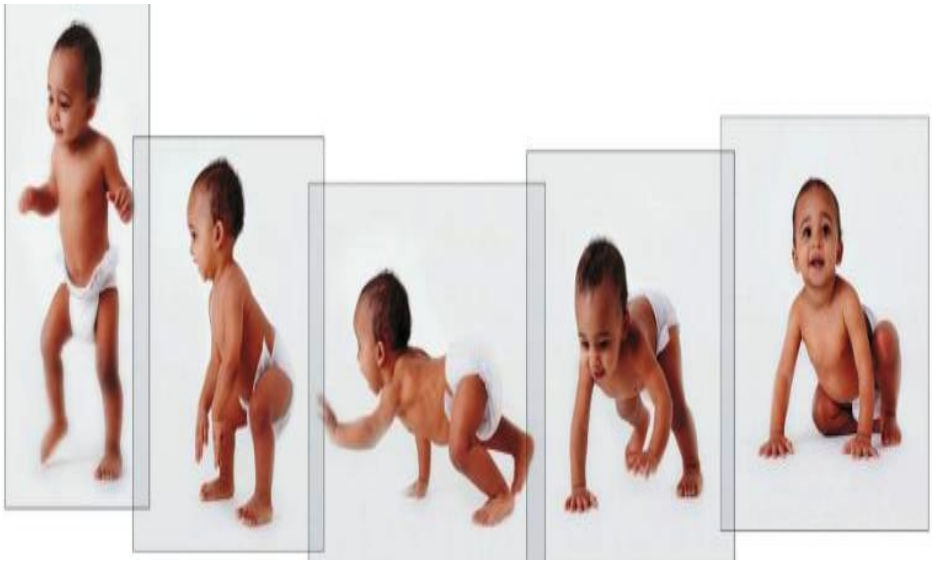
11 Month	**31. Fine prehensions. (pincer grasp)** 
	32. Raises to sit. 

12 Month	**33. Stands by furniture.** 
	34. Adjust two words. Know some objects by name, the child look towards an object If you ask him, without pointing the direction, (Child may need to be asked in his/her language – tik-tik for clock, gir-gir for fan, or pa-pa etc.)
	35. Says da-da. 

13 to 15 Month	**36. Inhibits on command.** 
	37. Midline skills. 
	38. Walks with help. 

13 to 15 Month	**39. Turns pages.** 
	40. Imitates words. **Child able to repeat repetitive sound with some meaning (like meh-<eh, Bhu-Bhu, Da-Da When asked? The parent should make those sounds and ask the child to reproduce them.**

16 to18 Month	**41. Stands alone.** 
	42.Spontaneous scribble 
	43. Throws balls. 

16 to18 Month	**44. Aufstehen 1.** **(**stand up from lying down position by his own efforts without any external help**)** 
	45. Walks alone. 

19 to 24 Month	**46. Gestures for wants.** **Child tell what he wants by pointing to the things and/or by gestures (nodding pushing away etc,** 
	47. Shows shoes, etc. Child able to identify some objects belonging to him/her (like shoe, dress, toy)
	48. Two words. The child able to speak two words meaningfully?(*This may be in his own language 'bhoo' for water, 'mum-mum' for food. Earlier, 'ba-ba' may be babbling, now it may mean a particular person*
	49.Walks up &down stairs with help 
	50. Words for wants. Child use words to tell what he wants – may be in 'baby' language?

25 to30 Month	**51. Two words sentences.** Child able to speak a meaningful sentence of two words? (*e.g. papa out*)
	52. Names three objects. Child able to name three common objects (ball, fan, mama. Papa etc.)(*The child may speak in 'baby' language*)
	53. Stands on one foot. 
	54. Walks up & down stairs without help. 

Egyptian Developmental Screening Chart (EDSC) Arabic checklist

بيانات التطور العقلى والحركى :			
العمر	البند		
شهر	1-يحرك يداه وقدميه علي الجانبين (يشقل بيديه ورجليه)	نعم ☐	لا ☐
	2-يركز بعينيه علي وجه الام للحظات او للضوء	نعم ☐	لا ☐
شهران	3-يحرك رأسه للجانبين وهو نائم علي بطنه	نعم ☐	لا ☐
	4-يتخض او يسكت عند سماع الأصوات العاليه مثل(الكلام،الشخشيخه)	نعم ☐	لا ☐
	5-يتابع بعينيه الام عندما تتحرك او عند تحريك لعبه امامه	نعم ☐	لا ☐
	6-بيحرك عينيه ليكتشف المكان حوله محاولا ملاحظة شئ أمامه.	نعم ☐	لا ☐
3 أشهر	7-يبتسم وبيناغي بصوت واضح عند الكلام معه أو أصدار أصوات له.	نعم ☐	لا ☐
	8-هل الطفل قادر علي النظر حوله في كل الاتجاهات (لاعلي- أسفل،يمينا-يسارا).	نعم ☐	لا ☐
	9-يرفع رأسه لفتره قصيره(بترنح) عندما تحمله الام علي كتفها	نعم ☐	لا ☐
4 أشهر	10-يرفع رأسه بثبات عاليا عند جذبه من زراعيه ليجلس أو رفعه قائما من أسفل الباط .	نعم ☐	لا ☐
	11-يبتسم عند رؤيه امه، يهدأ عندما تأتي.	نعم ☐	لا ☐
	12-عندما ينام علي بطنه هل يكون قادر علي رفع صدره من علي السرير بالأستناد علي مرفقه أو يرفع جسمه بلاستناد علي ذراعه.	نعم ☐	لا ☐
	13-عندما توضع شخشيخه بيده هل الطفل ينظر إليها،يضعها بفمه،يهزها أو يلعب بها بأي طريقه أخري.	نعم ☐	لا ☐
5 أشهر	14-هل الطفل يبدي إهتمام بالأشياء حوله ويحاول الوصول لها بمد ذراعه(لايشترط أن يستطيع الوصول لها)	نعم ☐	لا ☐
	15-يجلس مستند علي وساده او ذراع الام عندما تكون القدم مفروده. يمكن أن تختبر بواسطه الطبيب.	نعم ☐	لا ☐
	16-يلتفت للاصوات المختلفه (الناس ، التلفاز أو صوت الشخشيخه)	نعم ☐	لا ☐
6 أشهر	17-بيتقلب من علي ظهره الي جانبه	نعم ☐	لا ☐
	18-هل الطفل يلعب بالورق عند إعطائه له مثل (وضعها بفمه أو يطويها بيده لتصدر أصوات)	نعم ☐	لا ☐
	19-يقلق من الغرباء (يبكي ،يبعد ،يحدق)	نعم ☐	لا ☐

7 أشهر	20-يهم ليجلس بمفرده من وضع الأستلقاء عندما يمد الأهل يده لهم ؛دون مساعده لشد الطفل.	نعم ☐	لا ☐
	21-يضرب الاشياء ببعض أو بالأرض لأصدار أصوات مثل (المكعبات، الاطباق)	نعم ☐	لا ☐
	22-يجلس مستقيما دون الحاجه لدعم لعده دقائق	نعم ☐	لا ☐
8 أشهر	23-عند إعطاء الطفل لعبه في يده وهو ممسك بلعبه بيده الأخري هل يظل ممسك باللعبتين .	نعم ☐	لا ☐
	24-عندما تمد الأم يديها للطفل وهو جالس هل يحاول شد نفسه ليقف دون مساعده .	نعم ☐	لا ☐
	25-يضحك ،يصدر أصوات عند النظر للمرآه	نعم ☐	لا ☐
9 أشهر	26-يجلس دون مساعده وقادر علي الالتفات ،او يهم ليزحف محاول الوصل للعبه بعيده دون فقد توازنه.	نعم ☐	لا ☐
	27 – يشد مفرش لتقريب اللعبة منه (هل تشعر الأم أن الطفل يسحب المفرش بهدف الحصول علي اللعبة؟).	نعم ☐	لا ☐
10 أشهر	28-عندما تطلب منه لعبه يمد يده ليعطيها لك حتي لو لم يتركها.	نعم ☐	لا ☐
	29- الطفل يحبي أو يتحرك من مكانه اما بالحبو على البطن مثل الكوماند أو الزحف علي يديه و ركبتيه أو الزحف علي اليدين و القدمين مع المؤخرة في الهواء مثل الدب	نعم ☐	لا ☐
	30-هل الطفل يهز الشخشيخه عن قصد لتصدر أصوات.	نعم ☐	لا ☐
11 شهر	31-يمسك الاشياء بسلاسه بواسطه أطراف اصابعه السبابه والوسطي(مثل حبة أرز)	نعم ☐	لا ☐
	32-يجلس دون مساعده	نعم ☐	لا ☐
12 شهر	33-يقف ممسكا بالاثاث	نعم ☐	لا ☐
	34-يعرف بعض الأشياء بأسماءها عندما يسأل عن مكان شئ دون الأشاره اليه ،هل الطفل ينظر إليها.	نعم ☐	لا ☐

	35-يقول كلمه من مقطعين با –با ، ما – ما ،نا-نا	نعم ☐	لا ☐
13 الى 15 شهر	36- عند أمر الطفل بالتوقف عن فعل شئ اثناء أنشغاله به ، هل يتوقف ولو للحظات؟ (عندما تأمر الام بحذم و ليس بالتهديد) مثال: كخ أبعدها او اوف شيل ايديك	نعم ☐	لا ☐
	37-يصفق أو يمسك لعبه علي جانبه الايسر بيده اليمني ، يلمس ذراعه الايسر بيديه اليمني، يضع رجل علي رجل وهو نائم علي ظهره.	نعم ☐	لا ☐
	38-يمشي بضع خطوات وهو ممسك بيدين الأم.(لا يعتد بالمشايه او الاثاث الصغير)	نعم ☐	لا ☐
	39-يقلب الصفحات لمشاهدة صور أكثر(أم يحاول قطع الورق فقط)	نعم ☐	لا ☐
	40- يقصد الطفل ان يصدر أصوات ذات معني شبيه للكلمات التي يرددها الاهل امامه ليقلدها. مثال: ما-ما، با-با، تا-تا	نعم ☐	لا ☐
16 الى 18 شهر	41-يقف دون مساعده لفتره قصيره بعد مساعدته علي الوقوف وأزاله الدعم عنه.	نعم ☐	لا ☐
	42-يشخبط بالألوان	نعم ☐	لا ☐
	43-يرمي الكره بعيداعندما يمسكها بيديه الاثنين.	نعم ☐	لا ☐
	44-هل الطفل يستطيع الوقوف من وضع الأستلقاء الي وضع الوقوف دون أي مساعده خارجيه	نعم ☐	لا ☐
	45-يمشي بضع خطوات بمفرده دون ان يمسك بشئ، حتي ولو كان لا يستطيع الوقوف بمفرده(عندما تساعده علي الوقوف وتتركه يستطيع ان يمشي)	نعم ☐	لا ☐
19 الى 24 شهر	46-يهز رأسه بالرفض ،يشير لكوب الماء ليشرب ، يشير للعبه يريدها ويبكي لاحضارها	نعم ☐	لا ☐
	47-يتعرف علي أشياءه مثل(حذائه، لعبته،ملابسه)	نعم ☐	لا ☐
	48-ينطق كلمتين واضحتين ويعرف معناهم مثل (بوه،مم)	نعم ☐	لا ☐

	49-يمسك بيد احد أو السور اثناء صعود وهبوط السلم(لا يعتد بالصعود زحفا او جالسا)	نعم ☐	لا ☐
	50-يشير للشئ مع قول اسمه صحيح (كره) حتي بلغه الطفل	نعم ☐	لا ☐
25 الى 30 شهر	51-يتحدث بجمله مكونه من كلمتين مثل (اريد اشرب ،اريد اكل، بابا خارج)	نعم ☐	لا ☐
	52- يسمي ثلاثه أشياء بأسمائها مثل صوره كلب، قطه ، حصان، بابا ،ماما)	نعم ☐	لا ☐
	53-يقف علي قدم واحده (مثال: عند لبس البنطلون او الحذاء)	نعم ☐	لا ☐
	54-يستطيع ان يصعد ويهبط دون ان يمسك بالسور	نعم ☐	لا ☐

Egyptian Developmental Screening Chart (EDSC)
English checklist

Age	Items	Response
1st month	1. ARMS & Legs thrust in play	Yes ☐ NO ☐
	2. momentary regard	Yes ☐ NO ☐
2nd month	3. lateral head movement (prone)	Yes ☐ NO ☐
	4. responds to sound	Yes ☐ NO ☐
	5. Follows moving person	Yes ☐ NO ☐
	6. Free inspection of surrounding	Yes ☐ NO ☐
3rd month	7. Social smile/vocalizes	Yes ☐ NO ☐
	8. Eye co-ordination	Yes ☐ NO ☐
	9. Head erect &steady	Yes ☐ NO ☐
4th month	10. Holds head steady	Yes ☐ NO ☐
	11. Recognizes mother	Yes ☐ NO ☐
	12. Elevates on arms	Yes ☐ NO ☐
	13. Play with rattle /hand play	Yes ☐ NO ☐
5th month	14. Reaches for dangling ring	
	15. Sits with slight support	Yes ☐ NO ☐
	16. Turns head to sounds	Yes ☐ NO ☐
6th month	17. Turns from back to side	Yes ☐ NO ☐
	18. Exploitive paper play	Yes ☐ NO ☐
	19. Discriminates strangers	Yes ☐ NO ☐
7th month	20. Pulls to sit	Yes ☐ NO ☐
	21. Bangs in play	Yes ☐ NO ☐
	22. Sits alone steadily	Yes ☐ NO ☐

8thmonth	23. Retails two things in two hands	Yes ☐ NO ☐
	24. Pulls to stand	Yes ☐ NO ☐
	25. Playful response to mirror image	Yes ☐ NO ☐
9thmonth	26. Sits with good co-ordination	Yes ☐ NO ☐
	27. Pulls string-secures toys	Yes ☐ NO ☐
10thmonth	28. Co-operates in play	Yes ☐ NO ☐
	29. Crawling (pre walking)	Yes ☐ NO ☐
	30. Rings bell purposefully	Yes ☐ NO ☐
11thmonth	31. Fine prehensions	Yes ☐ NO ☐
	32. Raises to sit	Yes ☐ NO ☐
12thmonth	33. Stands by furniture	Yes ☐ NO ☐
	34. Adjust two words	Yes ☐ NO ☐
	35. Says da-da	Yes ☐ NO ☐
13thto 15th month	36. Inhibits on command	Yes ☐ NO ☐
	37. Midline skills	Yes ☐ NO ☐
	38. Walks with help	Yes ☐ NO ☐
	39. Turns pages	Yes ☐ NO ☐
	40. Imitates words	Yes ☐ NO ☐
16thto18thmonth	41. Stands alone	Yes ☐ NO ☐
	42. Spontaneous scribble	Yes ☐ NO ☐
	43. Throws balls	Yes ☐ NO ☐
	44. Aufstehen 1.	Yes ☐ NO ☐
	45. Walks alone	Yes ☐ NO ☐

19th to 24th month	46. Gestures for wants	Yes	☐	NO	☐
	47. Shows shoes, etc.	Yes	☐	NO	☐
	48. Two words	Yes	☐	NO	☐
	49. Walks up &down stairs with help	Yes	☐	NO	☐
	50. Words for wants	Yes	☐	NO	☐
25th to30th month	51. Two words sentences	Yes	☐	NO	☐
	52. Names three objects	Yes	☐	NO	☐
	53. Stands on one foot	Yes	☐	NO	☐
	54. Walks up & down stairs without help	Yes	☐	NO	☐

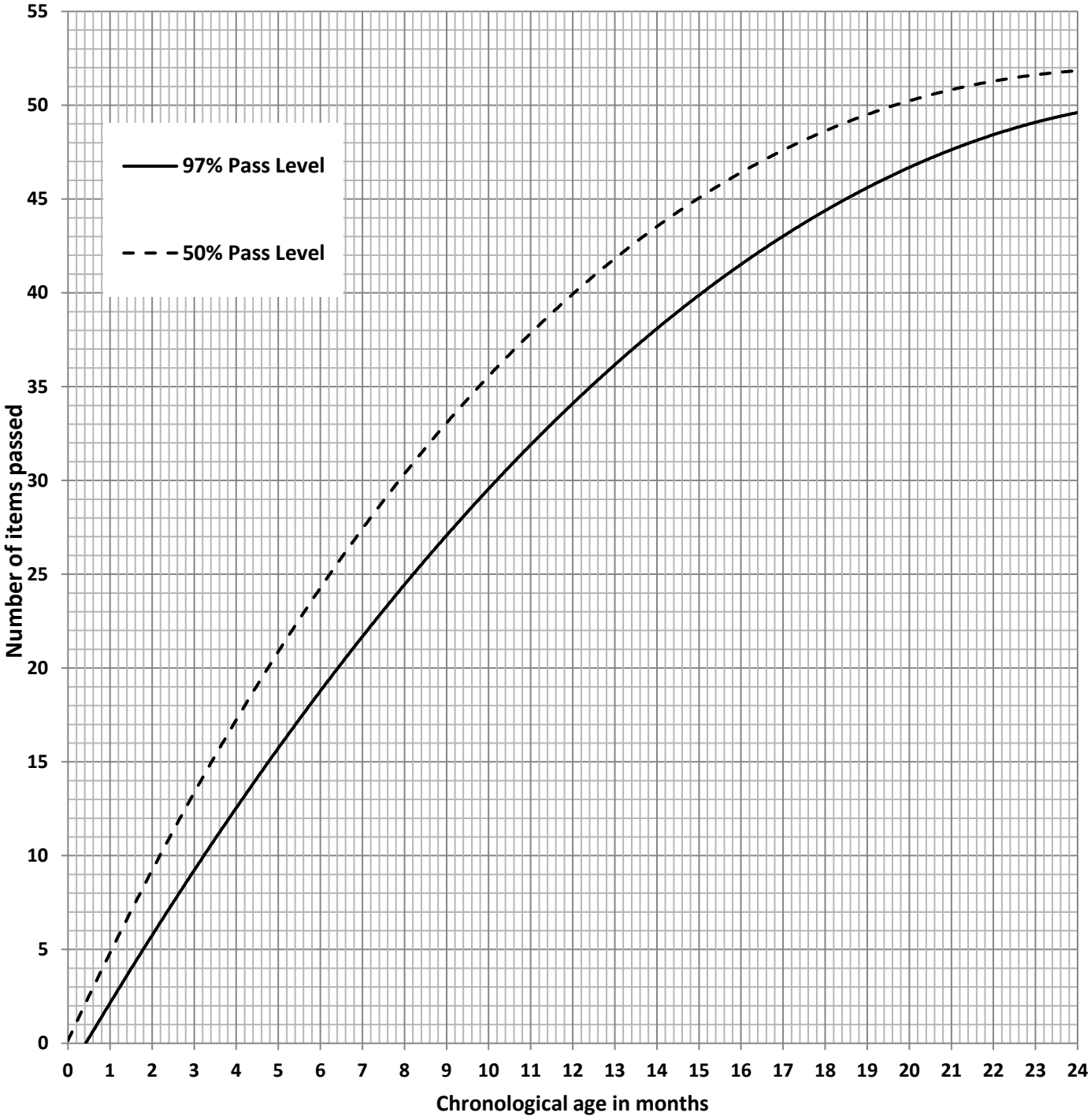


Figure (1): 50% and 97% pass level where chronological age in months plotted horizontally and number of items passed plotted vertically.

NB: Any child's score below 97% pass level considers developmentally delayed

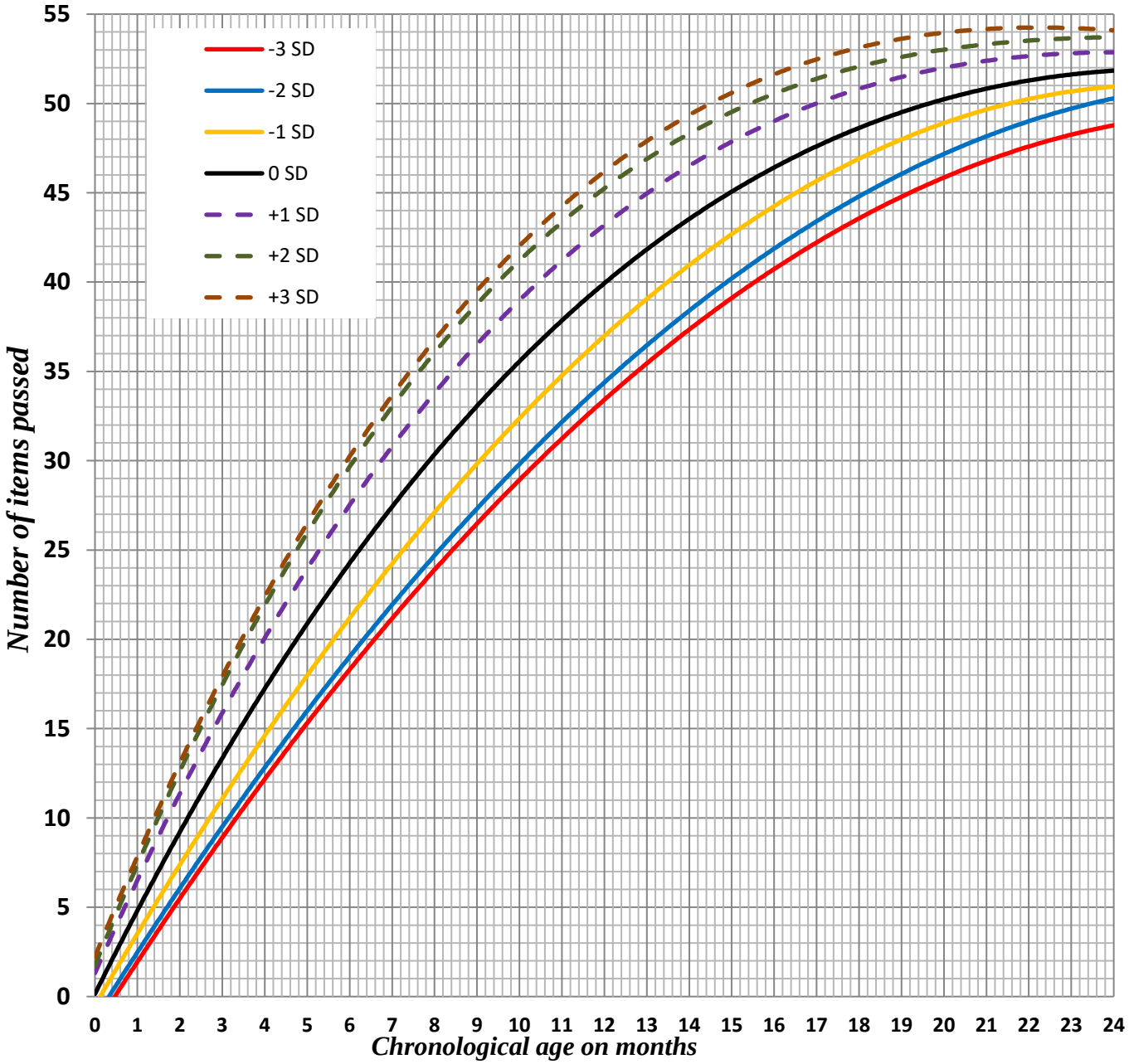


Figure (2): Z-score curve of Egyptian developmental screening chart (EDSC) of infants showing the age placement of each item at various percentage pass levels up to 24 month

NB: A Z-score curve of EDSC for children demonstrates relevant age placement of each item at various percentage passing levels and any child performance plotted above -2 SD curve was considered normal, while who recognized below -2SD was deemed developmentally delayed. The Z- score chart also can be used for motor and mental developmental follow-up.

How to apply EDSC checklist?

1. Ask about the chronological age of the child.
2. Ask about age- appropriate items (all items of this age group) from EDSC checklist.

N.B: Give one score for each item passed by the child to calculate his /her total score.

Child didn't pass age- appropriate items. (Didn't answer all or some of items of his /her age group)

Ask about the items of the age group that precedes his /her age-appropriate items on EDSC checklist until the last item the child can achieve

(Give one score for each item passed)

Put the score on the chart by plotting the total items passed against the chronological age

Child passed age- appropriate items (Passed all items of his /her age group

Child considered in normal range of his/her age group development

Ask for the next items (next age group) for age- appropriate items until the last item the child can achieve

(Give one score for each item passed)

The score is important in follow-up sessions. It helps determine if a child is showing regression or developmental progress in follow-up sessions.

Example (1)

An infant with a chronological age (CA) 12 month

Ask about age- appropriate items (33, 34 and 35).

Child passed 33, 34 and 35 items of his /her age group

Ask about items of the next age group (13-15months)

Items (36, 37, 38, 39 and 40)

If the child answered only items 38 and 39 of the next age group

Give one score for each item passed

His /her total score (total items passed) will be 37 (35 items+ 2 from the next age group)

Put the total item passed (37 score) against child chronological age (12 months)

On EDSC and Z score chart

Plotted as a red circle

On EDSC: the score in normal range between 50% and 97% pass levels

On Z score: lies on -1 SD which considered in normal range (above -2SD)

Child passed only item (33) of his /her age group

Give one score for each item passed

Ask about items of the age group precedes his /her age group (11month)

(Items 31 and 32)

If the child answered item 31 only of the preceded age group

Ask about items of the age group precedes his /her age group (10 month)

(Items 28, 29 and 30)

Child passed this age group items

His /her total score (total item passed) will be 32 (33 score that achieved from age-appropriate group minus 1 score not answered from the previous month {item 32})

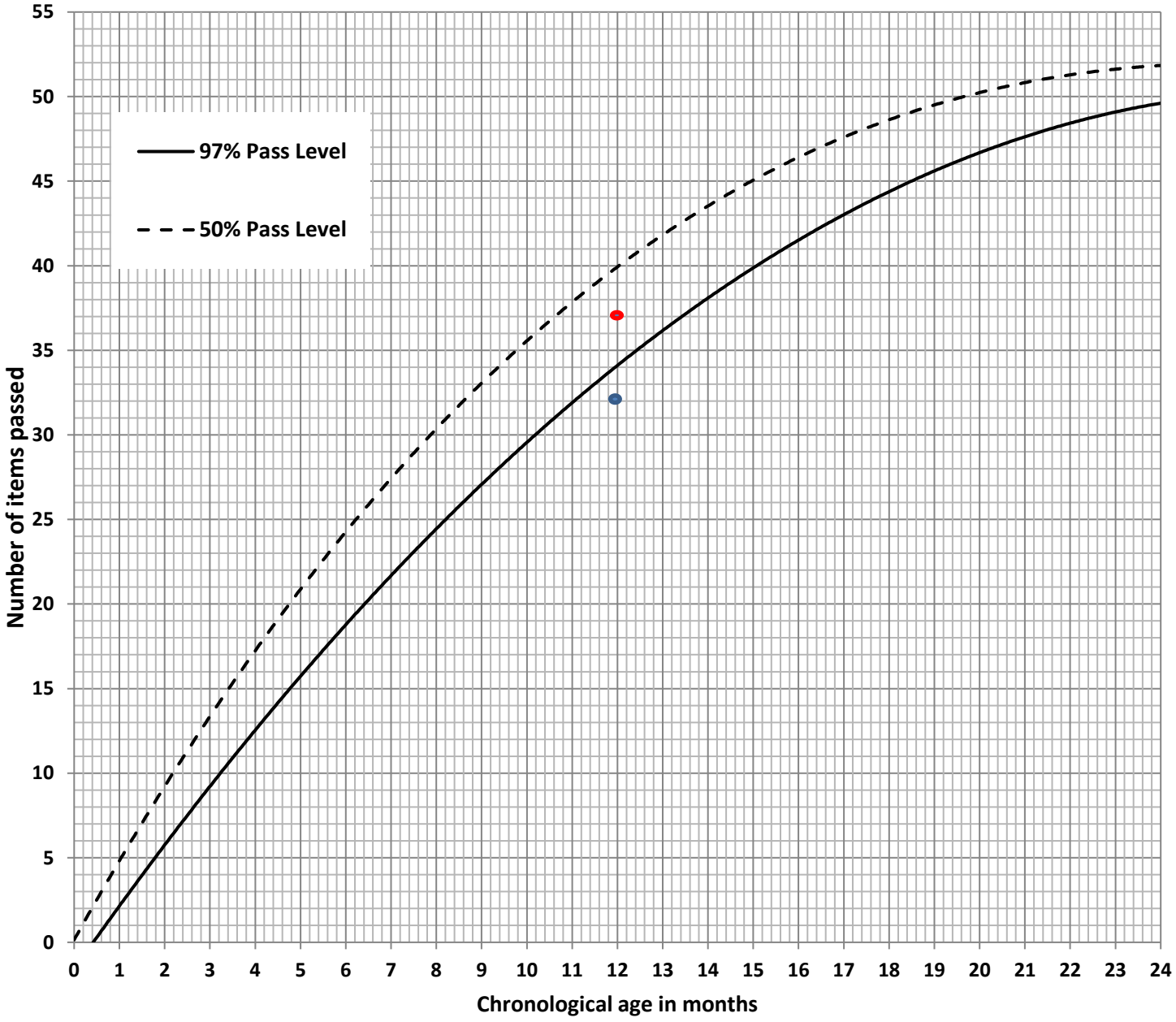
Put the total item passed (32 score) against child chronological age (12 months)

On EDSC and Z score chart

Plotted as a blue circle

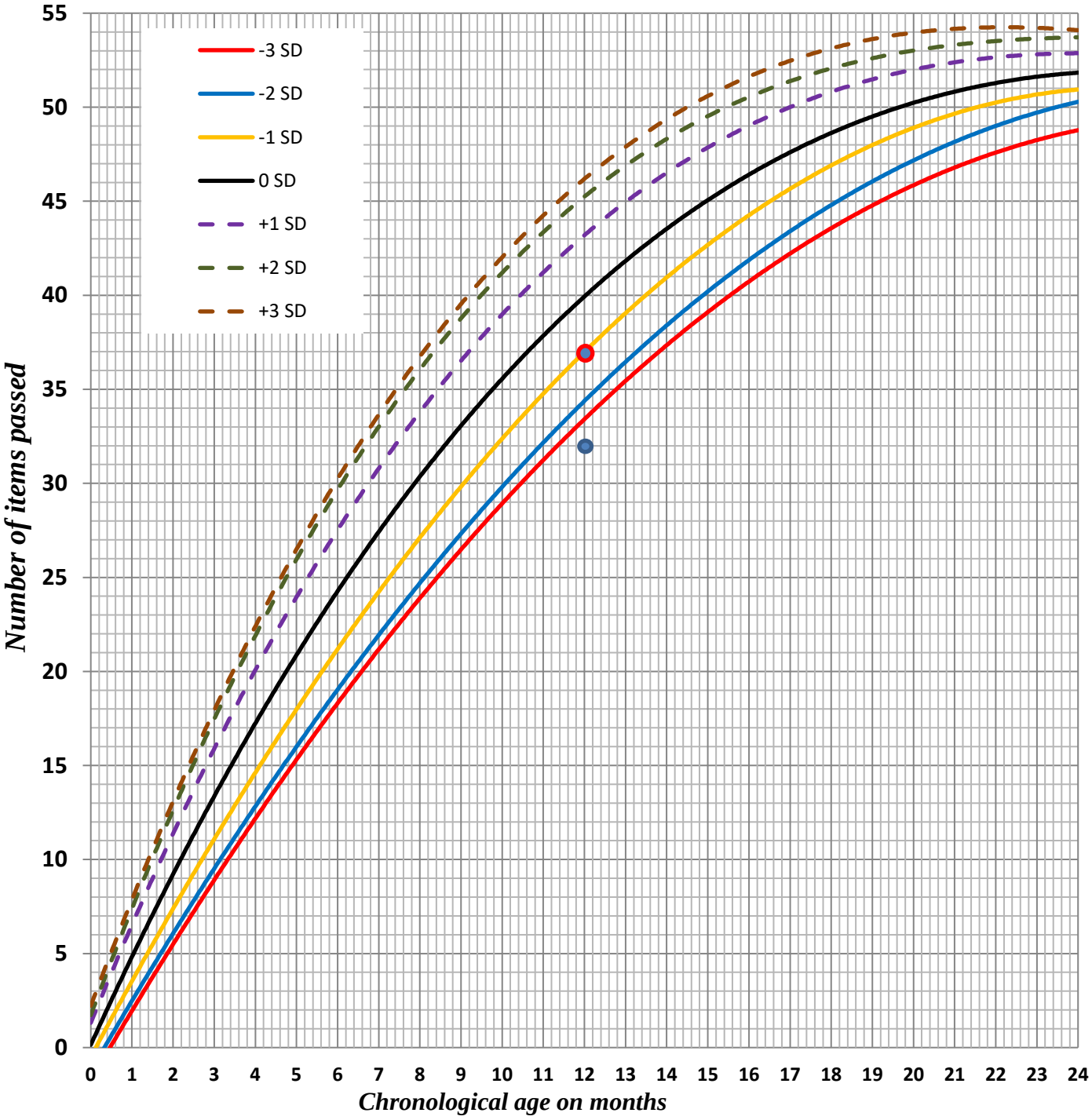
On EDSC: the score below 97% pass level (Developmentally delayed)

On Z score: lies below -3 SD considered developmentally delayed for further assessment



Red circle: **Shows score 37 that the child has achieved in example (1)**

Blue circle: **Shows score 32 that the child has achieved in example (1)**



Red circle: **Shows score 37 that the child has achieved in example (1)**

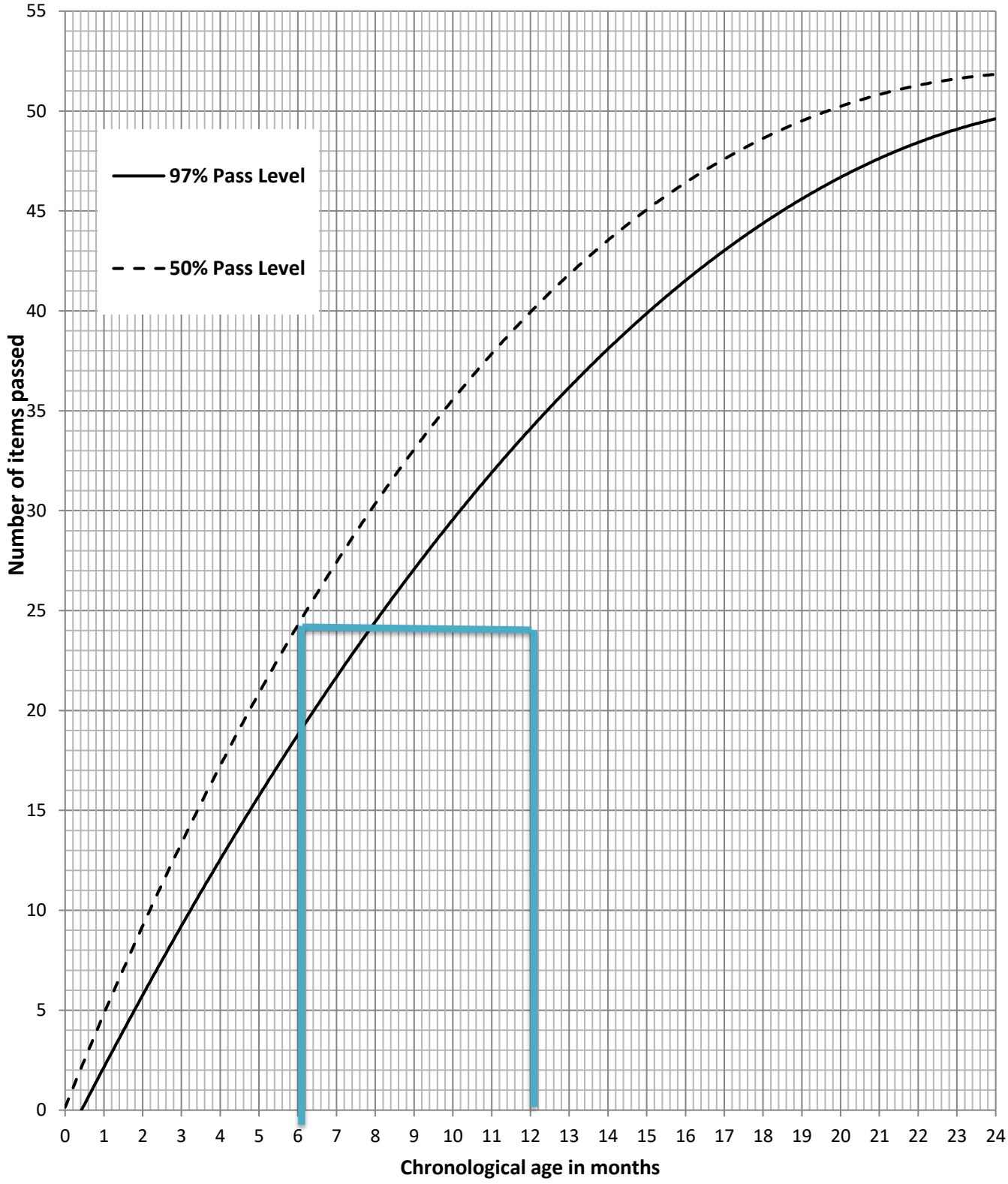
Blue circle: **Shows score 32 that the child has achieved in example (1)**

Example (2)

An infant with a chronological age (CA) ***12 months****:*

1) If the child has achieved a score of 24 item, it's obvious in the chart that the child's development is delayed (the score lies below 97% pass level).
2) If we need to determine his/her developmental age (DA), Draw a horizontal line parallel to the horizontal axis of chronological age from the achieved score (24) to reach the 50 % pass level then draw a vertical line to reach the actual developmental age of the child (6 months).
3) The developmental quotient (DQ) is calculated as {DQ=DA/CA}*100
   DQ= (6/12)*100= 50%. This means a developmental delay

NB: the child considers developmentally normal when the DQ is above 85%.


97% Pass Level
50% Pass Level
Number of items passed
Chronological age in months
0
5
10
15
20
25
30
35
40
45
50
55
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

Development and validation of Egyptian developmental screening chart for children from birth up to 30 months

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ABSTRACT

Background. Detecting developmental delay in children is an ongoing world commitment, especially for those below three years. To accurately assess the development of children; a culturally appropriate screening tool must be used. Egypt lacks such tool and multiple studies have shown that western tools are not suitable in other cultures.
Objectives. To develop and validate an easy, rapid, culturally appropriate and applicable screening chart for early detection of developmental delay among Egyptian children from birth up to 30 months and develop a Z-score chart for motor and mental development follow up based on our Egyptian screening chart.
Methods. A cross sectional randomized study was carried out on 1503 Egyptian children of both genders aged from birth up to 30 months assumed to have normal development according to the inclusion and exclusion criteria. They were selected from vaccination centers and well-baby clinics. Developmental milestones from Baroda development screening test (BDST) were applied on them after items were translated and adapted to Egyptian culture. Egyptian children developmental milestones scores were analyzed and carefully prepared in tables and charts. A 97% pass level of developmental achievements represents the threshold below which children are considered delayed. A Z-score chart for motor and mental development follow up was designed by calculating each age group achievement. The developed Egyptian developmental screening chart (EDSC) was validated against Ages and Stages Questionnaires (ASQ-3) as a reference standard in another different sample of 337 children in different age groups.
Results. The developed EDSC is represented in a chart format with two curves 50% and 97% pass level. Children considered delayed when the score below 97% pass level. Results revealed a statistically significant difference between EDSC and BDST at 50% and 97% pass levels. A Z-score chart for motor and mental development follow up was designed by calculating each age group achievement. EDSC sensitivity and specificity were calculated 84.38 (95% CI [67.21%–94.72%]) and 98.36 (95% CI [96.22%–99.47%]) respectively with an overall test accuracy 97.03 (95% CI [94.61%–98.57%]) ($p \leq 001$). Agreement between EDSC and ASQ-3 was high (kappa score was 0.827) with negative and positive agreement 98.36 and 84.38, respectively.

Submitted 20 May 2020
Accepted 14 October 2020
Published 11 November 2020

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Academic editor
Antonio Palazón-Bru

Additional Information and Declarations can be found on page 11

DOI **10.7717/peerj.10301**

How to cite this article El Shafie AM, Omar ZAL, Bashir MM, Mahmoud SF, Basma EM, Hussein AE, Mostafa AM, Bahbah WA. 2020. Development and validation of Egyptian developmental screening chart for children from birth up to 30 months. *PeerJ* **8**:e10301 http://doi.org/10.7717/peerj.10301

Conclusions. Extensive revision of the BDST was needed in order to create and validate a more culturally appropriate Egyptian screening chart. This is the first study to create and validate an Egyptian-specific screening tool, to be rapid and easy to use in Egypt for early detection of developmental delay and enabling early intervention practices. A Z-score curve is reliable for follow up motor and mental development by calculating each age group achievement.

Subjects Nutrition, Pediatrics, Psychiatry and Psychology, Public Health
Keywords Developmental delay, Egyptian Developmental Screening Chart, Screening tools, Validation, Z-score

INTRODUCTION

Almost 200 million children worldwide suffer from different forms of disability, the majority of them present in developing countries. Children in low and middle-income countries are at risk for not fulfilling their potential for physical and mental development due to poverty and other risk factors as malnutrition (*Fischer, Morris & Martines, 2014*; *Black et al., 2017*).

Developmental assessment of young children is a challenging task. Relying exclusively on clinical judgment alone may be misleading (*Council on Children With Disabilities et al., 2006*). Thus, screening tools are important to identify children for further testing and follow-up. A screening tool may be feasibly administered to the parents or tested on the child. Parent-administered screening tools are of great value especially in cases of children's sleepiness, irritability and illness. The range of sensitivity and specificity of 70% to 80% has been considered suitable for developmental screening tools (*Urkin, Bar-David & Porter, 2015*; *Oberklaid & Drever, 2011*).

Developmental screening is indicated whenever a problem is noticed during developmental surveillance or when doubts are raised by parents, caregivers or child health practitioners. It is more accurate when applying standardized assessments of children's developmental status rather than simple clinical impressions. The American academy of pediatrics recommended administration of standardized screening tools at the ages (9, 11, 24, or 30 months) in order to produce effective developmental surveillance. It also recommends that performing repeated developmental screening is more accurate and reliable than single assessment (*Bright Futures Steering Committee & Medical Home Initiatives for Children With Special Needs Project Advisory Committee, 2006*; *Lipkin & Macias, 2020*).

One of the effective screening tools is the Baroda development screening test (BDST) by Phatak and Khurana (*Phatak & Khurana, 1991*). It is a simple, rapid, and cost-effective tool. BDST checklist contains 54 items selected from the norms giving in Bayley Developmental Screening Test of infants (Baroda norms) (*Bayley, 1969*; *Bell & Allen, 2000*). Baroda screening test considered valid in field survey, as well as clinical practices with sensitivity and specificity 95%–65% in sequence (*Phatak & Khurana, 1991*).

There are other screening tools created in high income countries such as the Ages and Stages questionnaire (ASQ) which is a parent report tool designed and developed by *Squires, Bricker & Twombly (2009)*. The ASQ consisting of 21 questionnaires (30-items each) spanning the age of 2–60 months, with an overall sensitivity of 75% and specificity of 86% (*Singh, Yeh & Blanchard, 2017*). Another one, Denver Developmental Materials II (formerly DDST), was developed to be used by professionals or trained paraprofessionals to determine if a child's development is within the normal range (*Drachler et al., 2005*). Other tools developed in low- and middle-income countries (LMIC) include the Trivandrum Developmental Screening Chart (TDSC), which is simple, short and requires limited training for identifying children who have developmental delays up to 2.5 years (*Fischer, Morris & Martines, 2014*; *Nair et al., 1991*). The Guide for Monitoring Child Development in Turkey is another screening tool described as a brief, open-ended, pre-coded interview with the primary caregiver for children from 0 to 2 year(s) of age (*Ertem et al., 2008*), as well as the Malawian Developmental Assessment Tool which revealed a good validity in targeting children from birth up to six years (*Gladstone et al., 2008*).

This study aims to develop and validate an easy, rapid, culturally appropriate and applicable screening chart for early detection of developmental delay among Egyptian children from birth up to 30 months and develop a Z-score chart for children follow up based on our Egyptian screening chart.

MATERIALS & METHODS

The study was conducted in two steps to develop and validate the Egyptian developmental screening chart (EDSC) from January 2019 till January 2020 in Egypt. The University of the Menoufia granted Ethical approval to carry out the study within its facilities (Ethical Application Ref: jm420-c5a3d, Institutional Review Boards IRB Approval ID: 180112Ped). Written consent was obtained from parents/or guardians who were informed about the objective of the study, its benefits and the absence of any risk associated with the participation of their children.

Step 1: Instrument development

Participants

A cross sectional randomized study was implemented on 1,503 normally developed Egyptian children aged from birth up to 30 months at vaccination centers and well-baby clinics. The minimum sample size of 1,500 children was calculated as adequate sample required to perform the study assuming a significance level of 95% ($\alpha = 0.05$), and statistical power (1–β) of 80% (*Daniel, 1991*; *Killeen, 2005*). The sample size was calculated according to *Charan & Biswas (2013)*. Online Open Source Epidemiologic Statistics for Public Health was also used to confirm the calculation (*Dean, Sullivan & Soe, 2013*).

Full term children from birth up to 30 months of age with anthropometric measurements (weight, length/ height and head circumference) within normal range for age according to WHO growth charts were included in the study (*WHO Multicentre Growth Reference Study Group, 2006*). Any child had history of prematurity, hospital admission including neonatal intensive-care unit (NICU), low socioeconomic level, malnourished according

to WHO (≤-2 standard deviation of weight to length/ height), chronic diseases (cardiac, hematological, chest or endocrine diseases) and developmental or physical disabilities was excluded.

A total number of 1,600 children were enrolled in the study. Exclusion criteria were applied to 97 children leaving 1503 children as a final total sample to be included in the study. The selected Children were divided into 30 groups based on their chronological age (CA), with each age group consisted of 44 to 58 children.

Milestones and chart development

EDSC checklist based on BDST questionnaire. BDST questionnaire consists of 54 items 22 motor (gross and fine motor) and 32 mental (cognitive, social and language). These items were chosen carefully from Bayley scale of infants which consist of 230 items (67 motor and 163 for mental development). Milestones were arranged from 0 to 30 months of age in an ascending order. Our research team discussed the cultural appropriateness of Baroda items and translated it to Arabic. Then items were clarified to the parents/or guardians with their local expressions till parents/or guardians could easily understand and answer unequivocally. A training workshop was provided for the field staff to explain the items on the checklist and how to conduct an interview with the parents/or guardians. A pilot study of 150 children was designed (five children per month) to test all items of the developmental checklist for Egyptian children and also to test and standardize the capabilities of the involved team before proceeding to the main data collection. The pilot study concluded that the data collector team was able to understand and apply the items, parents were apple to understand and answer questions easily with yes or no, items didn't return with missing answers and there was a certain degree of variability in most of items.

The scores of checklist items passed by children were analyzed and tabulated. 97% pass level of developmental scores of children was taken as a reference. The 50% and 97% level age placement of each item were plotted against its corresponding CA of children and then smoothed into two curves. Any child score below 97% pass level considered delayed.

A Z-score chart for motor and mental development follow up was designed also by calculating each age group achievement.

Measurements and data collection

Socioeconomic and demographic factors were collected using Fahmy schedule which is used for estimating socioeconomic standard in Egypt (*Fahmy et al., 2015*). Low socioeconomic status was excluded as it has a negative environmental influence on child development, for example; malnutrition can influence development by causing him or her to fuss more or play less and affect brain development function (*Prado & Kathryn, 2014*), also Poverty and social-cultural factors increase both physiological and behavioral deficits (*Fernald et al., 2017*).

Children were examined for any developmental or physical disability. Weight, recumbent length (for less than 24 months), height (from 24 months to 30 months) and head circumference (HC) were measured. Weight was measured by (LAICA model bf 2051, Italy) till the age of 2 years then another scale (Beurer model GS 11, Germany) was used till age of 30 month. The length of children was measured by a recumbent baby length

scale. The height was measured by Harpenden fixed stadiometer. HC was measured by flat metal tape. This is followed by an interview to their parents/or guardians to complete the developmental checklist.

Step 2: Validation of EDSC

A validation study to EDSC was done against ASQ-3 as a gold standard tool (*Squires, Bricker & Twombly, 2009*). A different sample of 337children were enrolled in a cross sectional randomized study from vaccination centers and well-baby clinics. A sample size of 299 children was calculated as enough required sample to conduct this agreement study, assuming that all individual but one pair agree with each other (*Liao, 2010*). A total number of 345 children were enrolled in the study. Exclusion criteria were applied to 8 children leaving 337 children as a final total sample. The selected children were divided into 15 groups based on their CA (first 15 age groups in the ASQ-3) ranging from 2 to 30 months. Children suffered from acute severe illness or previously diagnosed with a developmental disorder were excluded.

EDSC checklist was applied to the parents/or guardians and the score was calculated by one of our team work. After obtaining informed consent, a detailed clinical evaluation was done. 97% pass level is determined as a cut off point, any child failed to pass above the 97% criterion was defined as 'delayed'. ASQ-3 was also applied to the same participants as a reference standard by another observer in our team who was blinded to the results of EDSC. ASQ-3 questionnaire contains 30 questions for each specific age group. These questions examine five domains: Fine Motor, Gross Motor, Communication, Problem-Solving and Personal-Social; each domain includes 6 questions that can be answered with a yes (10 points), sometimes (5 points) or not yet (0 points), as well as nine open-ended questions. Scores falling in the white area indicate the child is developing typically. Scores falling in the gray area mean the child should be monitored and another screening may be needed later on. Scores falling in the black area (cut off point) mean that the child may be at risk for developmental delay and should be referred for further assessment (2 SD below mean).

Statistical analysis

Data were collected and entered into the computer using SPSS (Statistical Package for Social Science) a program for statistical analysis (version 21) (IBM Corp., Armonk, NY, USA). Data were entered as numerical or categorical, as appropriate and described using minimum, maximum, mean, standard deviation. Categorical variables were described using frequency and percentage. Comparisons were carried out between two studied dependent (developmental age of the Egyptian children on 50% and 97% pass level using Baroda curve vs the developmental age of the same child using EDSC) normally distributed variables using paired *t*-test (*Box, 1987*). A Z-score was calculated for each age group at the following: -3, -2, -1, 0,1,2,3 equally in sequence the percentiles (0.2nd, 2.3rd, 16th, 50th, 84th, 97.7th, 99.8th respectively) (*Wang & Chen, 2012*). Polynomial trend line curves were used by Microsoft Excel (Microsoft Office Professional). (*Hargreaves & McWilliams, 2010*)

Validation evaluation was carried out using MedCalc Software version 14 (*DeLong, DeLong & Clarke-Pearson, 1988*). The following tests were carried out: Sensitivity (true

positive rate), Specificity, positive and negative predictive value as well as accuracy (*Zhou, McClish & Obuchowski,2009*). Kappa values interpretations 0.75 considered as excellent, 0.40 to 0.75 as fair to good, and below 0.40 as poor according to fleiss's equally arbitrary guidelines (*Fleiss, 1981*). An alpha level was set to 5% with a significance level of 95%.

RESULTS

A total sample of 1503 children were enrolled in EDSC design, 785 (52.2%) of them were males and 718 (47.8%) were females. The socioeconomic standard of the participants was high in 1076 (71.6%) and moderate in 427 (28.4%) children. The Egyptian screening chart's vertical line indicates the number of items passed plotted against the CA on the horizontal one. The 50% pass level curve drawn intermittently, whereas the 97% pass level curve drawn continuously. Any child score below the continuous line was considered developmentally delayed. Developmental age (DA) can be calculated from EDSC by intersection of the horizontal level of the score with the 50% pass level curve. Also, Developmental Quotient (DQ) can be calculated directly from the EDSC by the equation (DQ = (DA/CA)× 100) (Fig. 1).

Statistically, there was a significant difference between EDSC of children compared with BDST, with p-value ≤0.001, calculated by measuring the Egyptian children developmental age on both charts at 50% and 97% passing levels. (Table 1). A Z-score curve of EDSC for children demonstrated relevant age placement of each item at various percentage passing levels and any child performance plotted above -2SD curve was considered normal, while who recognized below -2SD was deemed developmentally delayed .The Z-score chart also can be used for motor and mental development follow up (Fig. 2).

Validation of EDSC against ASQ-3 (Reference standard) was assessed in a different sample of 337 children 173 (51.3%) females and 164 (48.7%) males. Child's score lie below 97% pass level was considered "EDSC delay" (Tool positive). The sensitivity and specificity of EDSC was found 84.38 (95% CI [67.21%–94.72%]) and 98.36 (95% CI [96.22%–99.47%]) respectively with an overall test accuracy 97.03 (95% CI [94.61%–98.57%]) ($p \leq .001$). Negative and positive agreement between EDSC and ASQ were 98.36 and 84.38 respectively (Table 2). When suspected cases were considered as delayed, the calculated kappa measure of agreement between EDSC and ASQ-3 was 0.827 (95% CI [0.723–0.932]) ($p = 0.000$) (Table 3).

DISCUSSION

Child assessment in developed countries often uses Western developmental tools (e.g., Bayley scales and the Denver II), which have been designed and validated in Western countries and have been used in non-Western or low and middle-income (LAMI) countries only by translation to another languages (*Ertem et al., 2008*; *Gladstone et al., 2008*). These translations may not meet local typicality and culture specificity leading to misinterpretation of the results (*Sabanathan, Wills & Gladstone, 2015*). For example, all domains of Western tests have some items that are culturally inappropriate for rural Africa,

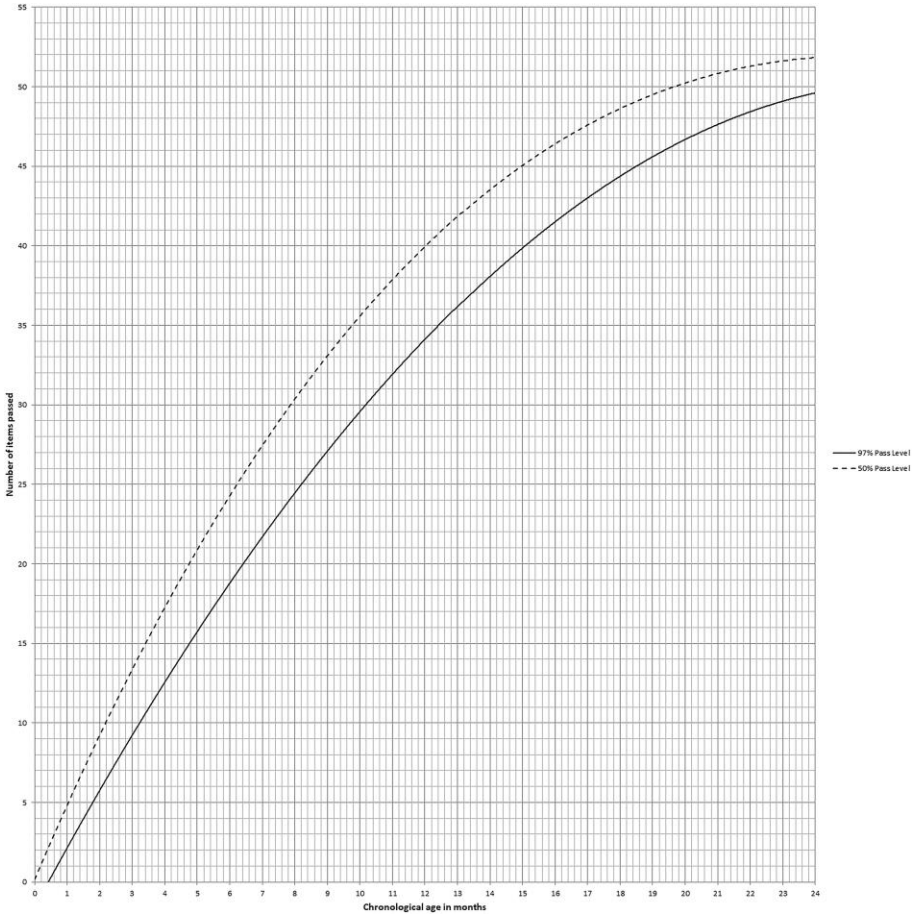

Figure 1 **Shows 50% and 97% pass level where chronological age plotted horizontally and number of items passed plotted vertically.**

such as prepare 'cereal', 'play board games' and other uncommon activities (*Gladstone et al., 2008*).

Lack of appropriate instruments in low and middle income countries is a major barrier to monitor child development (*Engle et al., 2007*). LMIC tried to adopt internationally standardized tests that have been proven to measure a construct of child development through time and across cultural diversity (*Amod, Cockcroft & Soellaart, 2007*).

Chunsuwan and Hansakunachai (*Chunsuwan, Hansakunachai & Pornsamrit, 2016*) claimed that using instruments developed mainly from a single culture may not provide the same results with another due to the cultural influence, which is called a deviant development (*Duc, 2016*; *Toh et al., 2017*). Also, other studies have contended the importance of making more efforts in the development of screening tools that respect the local differences (*Fernald et al.,2017*).

A developmental screening tool for community should be simple, cost-efficient, less time consuming, valid and easy to understand by health workers and parents. The tool

Table 1 Comparison between developmental age of Egyptian and Baroda charts at 50% and 97% pass level.

Age category in months	DA 50%		*P* value	DA 97%		*P* value
	BARODA	EGYPTIAN		BARODA	EGYPTIAN	
1.0	0.48 ± 0.405	0.86 ± 0.284	$t = 8.874$ $p = 0.000$*	1.80 ± 0.319	1.53 ± 0.339	$t = 22.844$ $p = 0.000$*
2.0	2.23 ± 0.697	2.73 ± 0.751	$t = 35.133$ $p = 0.000$*	4.12 ± 0.955	3.71 ± 0.848	$t = 18.920$ $p = 0.000$*
3.0	2.45 ± 0.540	3.00 ± 0.571	$t = 47.364$ $p = 0.000$*	4.48 ± 0.744	4.00 ± 0.631	$t = 22.862$ $p = 0.000$*
4.0	3.87 ± 0.896	4.48 ± 0.895	$t = 55.874$ $p = 0.000$*	6.18 ± 0.999	5.67 ± 1.027	$t = 24.461$ $p = 0.000$*
5.0	4.26 ± 0.779	4.89 ± 0.768	$t = 73.817$ $p = 0.000$*	6.64 ± 0.795	6.15 ± 0.873	$t = 22.117$ $p = 0.000$*
6.0	6.25 ± 0.812	7.00 ± 1.018	$t = 14.777$ $p = 0.000$*	8.89 ± 0.986	8.55 ± 1.055	$t = 15.113$ $p = 0.000$*
7.0	6.30 ± 0.974	7.13 ± 1.222	$t = 13.742$ $p = 0.000$*	8.95 ± 1.206	8.64 ± 1.287	$t = 13.864$ $p = 0.000$*
8.0	7.29 ± 0.844	8.40 ± 1.012	$t = 15.891$ $p = 0.000$*	10.17 ± 1.015	9.97 ± 1.124	$t = 7.724$ $p = 0.000$*
9.0	8.10 ± 1.077	9.16 ± 1.198	$t = 24.003$ $p = 0.000$*	11.11 ± 1.250	11.00 ± 1.390	$t = 3.880$ $p = 0.000$*
10.0	9.55 ± 0.835	10.81 ± 1.016	$t = 46.485$ $p = 0.000$*	12.85 ± 1.045	12.92 ± 1.143	$t = 3.012$ $p = 0.000$*
11.0	10.66 ± 1.077	12.16 ± 1.288	$t = 47.653$ $p = 0.000$*	14.27 ± 1.350	14.47 ± 1.518	$t = 5.337$ $p = 0.000$*
12.0	11.30 ± 1.144	12.92 ± 1.332	$t = 57.061$ $p = 0.000$*	15.06 ± 1.379	15.35 ± 1.581	$t = 7.141$ $p = 0.000$*
13.0	11.49 ± 1.408	12.54 ± 1.625	$t = 14.308$ $p = 0.000$*	15.06 ± 1.705	15.42 ± 1.809	$t = 10.663$ $p = 0.000$*
14.0	12.34 ± 1.403	13.24 ± 1.637	$t = 10.463$ $p = 0.000$*	15.84 ± 1.809	16.33 ± 1.862	$t = 12.790$ $p = 0.000$*
15.0	13.13 ± 1.396	14.28 ± 1.733	$t = 15.038$ $p = 0.000$*	17.03 ± 2.161	17.49 ± 1.975	$t = 10.424$ $p = 0.000$*
16.0	14.13 ± 1.555	15.15 ± 1.924	$t = 14.768$ $p = 0.000$*	18.42 ± 2.580	18.78 ± 2.096	$t = 4.107$ $p = 0.000$*
17.0	15.31 ± 1.656	16.64 ± 1.771	$t = 26.917$ $p = 0.000$*	20.28 ± 2.871	20.40 ± 2.002	$t = 0.873$ $p = 0.387$ *NS*
18.0	15.88 ± 1.606	17.44 ± 1.893	$t = 22.052$ $p = 0.000$*	21.18 ± 2.525	20.99 ± 1.726	$t = 1.259$ $p = 0.215$
19.0	17.07 ± 1.544	18.24 ± 1.712	$t = 15.385$ $p = 0.000$*	22.93 ± 2.267	22.51 ± 1.827	$t = 2.888$ $p = 0.006$*
20.0	17.89 ± 1.946	19.20 ± 2.423	$t = 11.169$ $p = 0.000$*	23.78 ± 2.770	23.14 ± 2.249	$t = 3.621$ $p = 0.001$*
21.0	17.94 ± 1.705	19.20 ± 2.155	$t = 11.397$ $p = 0.000$*	24.04 ± 2.102	23.59 ± 2.092	$t = 3.359$ $p = 0.001$*
22.0	18.08 ± 1.687	19.40 ± 2.188	$t = 11.174$ $p = 0.000$*	24.25 ± 2.262	23.55 ± 2.031	$t = 4.320$ $p = 0.000$*

(*continued on next page*)

Table 1 (*continued*)

Age category in months	DA 50%		*P* value	DA 97%		*P* value
	BARODA	EGYPTIAN		BARODA	EGYPTIAN	
23.0	18.43 ± 1.932	19.92 ± 2.700	$t = 9.816$ $p = 0.000$*	24.08 ± 2.358	23.74 ± 2.326	$t = 3.461$ $p = 0.001$*
24.0	19.19 ± 1.671	21.02 ± 2.692	$t = 10.816$ $p = 0.000$*	25.18 ± 2.484	24.61 ± 2.198	$t = 4.316$ $p = 0.000$*
25.0	19.40 ± 1.525	21.02 ± 2.379	$t = 9.360$ $p = 0.000$*	25.31 ± 1.969	25.25 ± 2.104	$t = 1.250$ $p = 0.218$ *NS*
26.0	19.42 ± 1.496	21.13 ± 2.477	$t = 9.644$ $p = 0.000$*	25.33 ± 1.674	25.33 ± 2.168	$t = 1.226$ $p = 0.226$ *NS*
27.0	20.20 ± 1.145	22.43 ± 2.296	$t = 11.880$ $p = 0.000$*	25.78 ± 1.954	26.37 ± 1.764	$t = 0.709$ $p = 0.482$ *NS*
28.0	20.19 ± 1.331	22.38 ± 2.407	$t = 10.940$ $p = 0.000$*	25.96 ± 1.846	26.53 ± 1.930	$t = 3.516$ $p = 0.001$*
29.0	20.45 ± 1.306	23.10 ± 2.337	$t = 13.136$ $p = 0.000$*	26.76 ± 1.732	27.12 ± 1.914	$t = 3.649$ $p = 0.001$*
30.0	21.03 ± 0.969	24.37 ± 1.549	$t = 30.542$ $p = 0.000$*	24.94 ± 3.203	27.35 ± 1.857	$t = 0.837$ $p = 0.411$ *NS*

should consider cultural differences and reflect all developmental domains (*Nair et al., 2013*; *Chopra, Verma & Seetharaman, 1999*).

BDST have been used in Egypt for children motor and mental development assessment as a rapid, easy and valid test according to many studies (*Fischer, Morris & Martines, 2014*; *Robertson et al., 2012*). Items of the Indian BDST found to be simple, applicable and convenient to Egyptian society. If the child performance lies below the 97% pass level, it represents the vulnerable population that requires further investigation for developmental delay (3%). There was a significant difference between EDSC and BDST, this was identified by measuring the DA of children in either chart 50% and 97% passing level. So establishing an Egyptian developmental chart based on Egyptian norms would be more suitable to the Egyptian cultural context.

The EDSC is a sensitive and reliable screening test for developmental delay in infants and young children. It is not time-consuming, special test equipment is not needed, and developmental milestones need not be strictly memorized by the parents. The chart design is simple and conceptually clear for physicians and parents to demonstrate the general development of a child, whether normal or delayed. At follow-up, it is useful in portraying a child's continued progress or lack of progress.

A Z-score chart was developed to facilitate follow up of children motor and mental development. Any child's score below -2SD considered developmentally delayed and need follow-up for child's progress in future visits. Developmental screening tools of other nations didn't mention any trial to develop a Z-score chart for developmental follow up. So this study is the first study that had established developmental screening tool in the form of Z-score chart for follow up.

Validation of EDSC took place on other participants (either normal or delayed) against ASQ-3 which was the most appropriate gold standard for these age groups as it's a feasible screening tool, inexpensive, easy to use, and was appreciated by the parents (*Elbers et al.,*

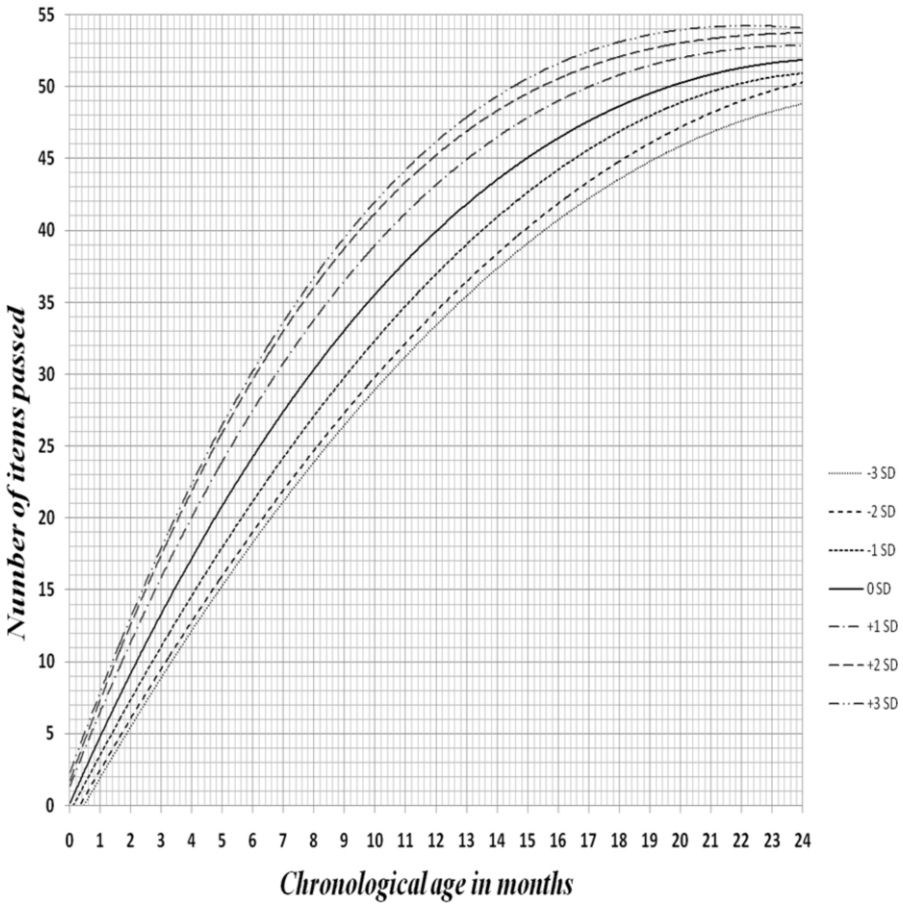

Figure 2 Z-score curve of Egyptian developmental screening chart of infants showing the age place- ment of each item at various percentage pass levels up to 24 months.

2008). What is more; Validity of ASQ-3 has been examined across different countries with an overall sensitivity of 75% and specificity of 86% (*Singh, Yeh & Blanchard, 2017*). The range of sensitivity and specificity of 70% to 80% have been considered suitable for developmental screening tools (*Urkin, Bar-David & Porter, 2015*; *Oberklaid & Drever, 2011*). ASQ-3 was found as a valid and reliable as a developmental screening tool in Egypt, this supported the idea of using it as a reference standard tool (*EL-Ella et al., 2017*).

In this study, the EDSC sensitivity was found to be 84.38% with specificity 98.36%. EDSC was developed as a screening tool for developmental delay; as test positive predictive value of 84.38%. In this position, one item delay as test positive gives an excellent 'Negative Predictive Value' of 98.36% which is acceptable for a screening tool. A perfect screening test should be with a high sensitivity, high negative predictive value and not having much compromise on specificity, EDSC fulfills these criteria.

Table 2 Test characteristics of EDSC against ASQ, having "EDSC Delay" as tool positive.

Criteria of test positive	Child delayed in EDSC taken "EDSC delay" (Tool positive)
Sensitivity[a]	84.38 (95% CI [67.21%–94.72%])
Specificity[b]	98.36 (95% CI [96.22%–99.47%])
Positive Predictive Value[c]	84.38 (95% CI [69.09%–92.88%])
Negative Predictive value[d]	98.36 (95% CI [96.41%–99.26%])
Overall Test Accuracy[e]	97.03 (95% CI [94.61%–98.57%]) ($p \leq .001$)
Proportions of specific agreement:	
Negative agreement	= 2 * 300 / (2*300 + 5 +5) = 98.36%
	= 2 * 27 / (2*27 + 5 +5) = 84.38%

Notes.
[a] *Sensitivity*: probability that a test result will be positive when the disease is present (true positive rate).
[b] *Specificity*: probability that a test result will be negative when the disease is not present (true negative rate).
[c] *Positive predictive value*: probability that the disease is present when the test is positive.
[d] *Negative predictive value*: probability that the disease is not present when the test is negative.
[e] *Accuracy*: overall probability that a patient is correctly classified.

Table 3 Agreement between Egyptian Developmental Screening Chart (EDSC) and ASQ-3 Questionnaire.

		ASQ Grade (Standard)		
		Under-developed	**Normal**	**Total**
Grade on Egyptian Developmental Screening Test	**Under-developed**	(TP) 27 (8.01%)	(FP) 5 (1.48%)	32 (9.50%)
	Normal	(FN) 5 (1.48%)	(TN) 300 (89.02%)	305 (90.50%)
	Total	32 (9.50%)	305 (90.50%)	337 (100.0%)
Kappa		0.827		
Standard error		0.053		
p value		0.000*		
Weighted kappa		0.827		
Standard error		0.053		
95% CI		0.723 to 0.932		

Notes.
*Significant difference means *P*- value < 0.05.
TP, True positive; FP, False positive; FN, False negative; TN, True negative

CONCLUSIONS

EDSC is valid, easy, rapid and culturally appropriate tool that facilitates early detection of developmental delay in children by pediatric practitioners and health workers.

Subsequently, we may stress the idea that each country build up its own screening tool. Furthermore, developing a Z-score chart renders a rapid and reliable chart to use at the follow-up stages of the Egyptian children motor and mental development.

ACKNOWLEDGEMENTS

We thank participant children, their parents/or guardians, and workers at the vaccination centers and well-baby clinics for their active participation in our study. The contents of this article and its opinions expressed within are those of the authors.

ADDITIONAL INFORMATION AND DECLARATIONS

Funding

The authors received no funding for this work.

Competing Interests

The authors declare there are no competing interests.

Author Contributions

- Ali M. El Shafie,Zein A.L. OmarandWael A. Bahbahconceived and designed the experiments, analyzed the data, authored or reviewed drafts of the paper, and approved the final draft.
- Mai M. Bashir,Sorour F. MahmoudandAhmed E Husseinconceived and designed the experiments, performed the experiments, analyzed the data, prepared figures and/or tables, authored or reviewed drafts of the paper, and approved the final draft.
- Elsayedamr M. Basmaanalyzed the data, prepared figures and/or tables, and approved the final draft.
- Alaa Mosad Mostafaperformed the experiments, analyzed the data, prepared figures and/or tables, authored or reviewed drafts of the paper, and approved the final draft.

Human Ethics

The following information was supplied relating to ethical approvals (i.e., approving body and any reference numbers):

The University of the Menoufia granted Ethical approval to carry out the study within its facilities (Ethical Application Ref: jm420-c5a3d, Institutional Review Boards IRB Approval ID: 180112Ped)

Data Availability

The following information was supplied regarding data availability:

Data are available as aSupplemental File.

Supplemental Information

Supplemental information for this article can be found online athttp://dx.doi.org/10.7717/peerj.10301#supplemental-information.

REFERENCES

Amod Z, Cockcroft K, Soellaart B. 2007. Use of the 1996 Griffiths mental development scales for infants: a pilot study with a black, South African sample year as. *Journal of Child & Adolescent Mental Health* **19(2)**:123–130.

Bayley N. 1969. *Bayley scales of infant development*. New York: The Psychological Corp.

Bell S, Allen B. 2000. Book review: bayley scales of infant development, second edition: manual. *Journal of Psychoeducational Assessment* **18(2)**:185–195 DOI 10.1177/073428290001800208.

Black MM, Walker SP, Fernald LCH, Andersen CT, DiGirolamo AM, Lu C, McCoy DC, Fink G, Shawar YR, Shiffman J, Devercelli AE, Wodon QT, Vargas-Baron E, Grantham-McGregor S. 2017. Early childhooddevelopment coming of age: science through the life course. *The Lancet* **389(10064)**:77–90 DOI 10.1016/S0140-6736(16)31389-7.

Box JF. 1987. Guinness, gosset, fisher, and small samples. *Statistical Science* **1987**:45–52.

Bright Futures Steering Committee, Medical Home Initiatives for Children With Special Needs Project Advisory Committee. 2006. Identifying infants and young children with developmental disorders in the medical home: an algorithm for developmental surveillance and screening. *Pediatrics* **118(1)**:405–420 DOI 10.1542/peds.2006-1231.

Charan J, Biswas T. 2013. How to calculate sample size for different study designs in medical research? *Indian Journal of Psychological Medicine* **35(2)**:121–126 DOI 10.4103/0253-7176.116232.

Council on Children With Disabilities, Section on Developmental Behavioral Pediatrics, Bright Futures Steering Committee, Medical Home Initiatives for Children With Special Needs Project Advisory Committee. 2006. Identifying infants and young children with developmental disorders in the medical home: an algorithm for developmental surveillance and screening [published correction appears in Pediatrics. 2006 Oct;118(4):1808-9]. *Pediatrics* **118(1)**:405–420 DOI 10.1542/peds.2006-1231.

Chopra G, Verma IC, Seetharaman P. 1999. Development and assessment of a screening test for detecting childhood disabilities. *Indian Journal of Pediatrics* **66(3)**:331–335 DOI 10.1007/BF02845517.

Chunsuwan I, Hansakunachai T, Pornsamrit S. 2016. Parent evaluation of developmental status (PEDS) in screening: the Thai experience. *Pediatrics International* **58(2)**:1277–1283DOI 10.1111/ped.13055.

Daniel WW. 1991. A foundation for analysis in the health sciences. In: *Biostatistics*. Toronto: John Wiley & Sons, 209–215.

Dean AG, Sullivan KM, Soe MM. 2013. OpenEpi: open source epidemiologic statistics for public health, version 2013. *Available at http://www.OpenEpi.com* updated 2013/04/06 (accessed on 09-05-2020).

DeLong ER, DeLong DM, Clarke-Pearson DL. 1988. Comparing the areas under two or more correlated receiver operating characteristic curves: a nonparametric approach. *Biometrics* **1988**:837–845.

Drachler M, De Castro Aerts DG, De Souza RM, De Carvalho Leite JC, Giugliani EJ, Marshall T. 2005. Social inequalities in maternal opinion of child development in southern Brazil. *Acta Paediatrica* **94**:1137–1139 DOI 10.1111/j.1651-2227.2005.tb02057.x.

Duc NHC. 2016. Developmental risk factors in Vietnamese preschool-age children: cross-sectional survey. *Pediatrics International* **58**:14–21DOI 10.1111/ped.12748.

EL-Ella S, Tawfik M, AboElFotoh W, Gomaa A. 2017. Assessment of intellectual development in preschool age in West of Menoufia Governorate, Egypt. *Menoufia Medical Journal* **734** Ahead of Print.

Elbers J, Macnab A, McLeod E, Gagnon F. 2008. The ages and stages questionnaires: feasibility of use as a screening tool for children in Canada. *Canadian Journal of Rural Medicine* **13(1)**:9–14.

Engle PL, Black MM, Behrman JR, deMello MC, Gertler PJ, Kapiriri L, Martorell R, Young ME, International Child Development Steering Group. 2007. Strategies to avoid the loss of developmental potential in more than 200 million children in the developing world. *Lancet* **369(9557)**:229–242DOI 10.1016/S0140-6736(07)60112-3.

Ertem IO, Dogan DG, Gok CG, Kizilates SU, Caliskan A, Atay G, Vatandas N, Karaaslan T, Baskan SG, Cicchetti DV. 2008. A guide for monitoring child development in low- and middle-income countries. *Pediatrics* **121(3)**:e581–9 DOI 10.1542/peds.2007-1771.

Fahmy SI, Nofal LM, Shehata SF, El Kady HM'IHK. 2015. Updating indicators for scaling the socioeconomic level of families for health research. *Journal of the Egyptian Public Health Association* **90(1)**:1–7DOI10.1097/01.EPX.0000461924.05829.93.

Fernald L, Prado E, Kariger P, Raikes A. 2017. *A toolkit for measuring early childhood development in low- and middle-income countries*. Washington, D.C.: International Bank for Reconstruction and Development / The World Bank.

Fischer VJ, Morris J, Martines J. 2014. Developmental screening tools: feasibility of use at primary healthcare level in low-and middle-income settings. *Journal of Health, Population and Nutrition* **32(2)**:314–326.

Fleiss JL. 1981. *Statistical methods for rates and proportions*. New York: Jhon Wiley, 38–46.

Gladstone MJ, Lancaster GA, Jones AP, Maleta K, Mtitimila E, Ashorn P. 2008. Can Western developmental screening tools be modified for use in a rural Malawian setting? *Archives of Disease in Childhood* **93**:23–29DOI 10.1136/adc.2006.095471.

Hargreaves BR, McWilliams TP. 2010. Polynomial trendline function flaws in Microsoft Excel. *Computational Statistics & Data Analysis* **54(4)**:1190–1196 DOI 10.1016/j.csda.2009.10.020.

Killeen PR. 2005. An alternative to null-hypothesis significance tests. *Psychological Science* **16(5)**:345–353DOI 10.1111/j.0956-7976.2005.01538.x.

Liao JJ. 2010. Sample size calculation for an agreement study. *Pharmaceutical Statistics* **9(2)**:125–132.

Lipkin PH, Macias MM. 2020. council on children with disability, section on developmental and behavioral pediatrics. Promoting optimal development: identifying infants and young children with developmental disorders through developmental surveillance and screening. *Pediatrics* **145(1)**:e20193449 DOI 10.1542/peds.2019-3449.

Nair MK, George B, Philip E, Lekshmi MA, Haran JC, Sathy N. 1991. Trivandrum developmental screening chart. *Indian Pediatrics* **28(8)**:869–872.

Nair MKC, Nair GH, George B, Suma N, Neethu C, Leena ML, Russell PSS. 2013. Development and validation of Trivandrum development screening chart for children aged 0-6 years [TDSC(0-6)]. *The Indian Journal of Pediatrics* **80(2)**:248–255 DOI 10.1007/s12098-013-1144-2.

Oberklaid F, Drever K. 2011. Is my child normal? Milestones and red flags for referral. *Australian Family Physician* **40(9)**:666–670.

Phatak AT, Khurana B. 1991. Baroda development screening test for infants. *Indian Pediatrics* **28(1)**:31–37.

Prado EL, Kathryn GD. 2014. Nutrition and brain development in early life. *Nutrition Reviews* **72(4)**:267–284 DOI 10.1111/nure.12102.

Robertson J, Hatton C, Emerson E, Yasamy MT. 2012. The identification of children with, or at significant risk of, intellectual disabilities in low- and middle-income countries: a review. *Journal of Applied Research in Intellect Disabilities* **25(2)**:99–118 DOI 10.1111/j.1468-3148.2011.00638.x.

Sabanathan S, Wills B, Gladstone M. 2015. Child development assessment tools in low-income and middle-income countries: how can we use them more appropriately?. *Archives of Disease in Childhood* **100**:482–488 DOI 10.1136/archdischild-2014-308114.

Singh A, Yeh CJ, Boone Blanchard S. 2017. Ages and stages questionnaire: a global screening scale. *Boletin Medico del Hospital Infantil de Mexico* **74(1)**:5–12 DOI 10.1016/j.bmhimx.2016.07.008.

Squires J, Bricker DD, Twombly E. 2009. *Ages & stages questionnaires*. Baltimore: Paul H. Brookes.

Toh TH, Lim BC, Bujang MAB, Haniff J, Wong SC, Abdullah MR. 2017. Mandarin parents' evaluation of developmental status in the detection of delays. *Pediatr Int* **59(8)**:861–868 DOI 10.1111/ped.13325.

Urkin J, Bar-David Y, Porter B. 2015. Should we consider alternatives to universal well-child behavioral-developmental screening? *Frontiers in Pediatrics* **3**:21 DOI 10.3389/fped.2015.00021.

Wang Y, Chen H-J. 2012. Use of percentiles and Z-scores in anthropometry. In: Preedy VR, ed. *Handbook of anthropometry: physical measures of human form in health and disease*. New York: Springer Science and Business Media, 29–48.

WHO Multicentre Growth Reference Study Group. 2006. WHO Child Growth Standards based on length/height, weight and age. *Acta Paediatrica* **450**:76–85.

Zhou XH, McClish DK, Obuchowski NA. 2009. *Statistical methods in diagnostic medicine*. New York: John Wiley & Sons.